METHOD FOR DETERMINING A CONNECTION PATH IN A COMMUNICATIONS NETWORK BETWEEN TWO ADJACENT NETWORK NODES~~.~~

CLAIM FOR PRIORITY

This application claims priority to International Application No. PCT/DE00/00315 which was published in the German language on February 2, 2000.

TECHNICAL FIELD OF THE INVENTION

The invention relates to a method of determining a connection path in a network, and in particular, to determining a connection path in a communications network between adjacent network nodes.

BACKGROUND OF THE INVENTION

Current communications networks have a plurality of network nodes which are intermeshed via connection paths. These are formed from a plurality of trunks which are combined to form trunk groups.

In current communications networks, different traffic combinations are routed via the connection paths arranged between two or more network nodes. Thus, for example, information can be transmitted by a synchronous (STM) or an asynchronous (ATM) transfer mode. The information may have different bandwidths. Thus, information which is transmitted in the form of narrowband signals is normally distinguished from information which is transmitted in the form of wideband or broadband signals. Special significance is therefore attached to the connection set-up between two adjacent nodes, i.e. network nodes interconnected via a trunk group.

Two decisions generally need to be made when a connection is set up in order to determine a connection

path between two adjacent network nodes. On the one hand, it must be decided which of the trunks of the trunk group which connects the network node in question still has adequate free capacity in order to set up a connection.

On the other hand, one of the connection paths which is conceivable in terms of available capacity must be selected in such a way that optimum grade of service is achieved. This is necessary insofar as the selected connection path is intended to ensure minimal blocking probability and associated low connection loss probability for subsequent connections.

A method with which these two tasks (search and selection) can be performed is referred to as a hunting strategy.

A hunting strategy of this type is disclosed in the document entitled "Probability of Loss of Data Traffics with different Bit Rates Hunting One Common PCM Channel, Proceedings of the 8th International Teletraffic Congress (ITC 8), 1976, pp. 525.1 -525.8, Lothar Katzschner, and Reinhard Scheller".

According to this document, a sequential search of all relevant trunks is carried out. An attempt is made here to determine the "smallest gap", which can still accommodate the new connection. The search process is started with the first trunk in the trunk group and is continued step-by-step until all trunks are checked. On the one hand, the transmission capacity which is still freely available on the trunk in relation to the peak bit rate of the connection which is to be accommodated is used as the selection criterion. An investigation is carried out to ascertain whether the transmission capacity which is still freely available is equal to or greater than the peak bit rate of this connection. In practice, a plurality of trunks may satisfy this

criterion. On the other hand, the trunk on which the least residual transmission capacity remains on acceptance of the new connection is then determined. The new connection is accepted on this trunk. If no adequate free transmission capacity is found, the connection concerned is rejected.

This known method was developed in particular for a homogeneous traffic characteristic, where each connection set-up began with the same capacity requirement of 64 kbit/s per connection. However, this traffic homogeneity on connection set-up is often no longer available in current communications networks. Along with conventional 64 kbit/s narrowband connections, n x 64 kbit/s wideband connections, for example, occur (in the case of STM-based, connection-oriented, multiple-rate services), or even broadband connections with any given bit rate granularity in the case of ATM traffic.

However, this creates completely new requirements for the connection set-up. Thus, the traffic performance capability must equally be as high and robust as possible with minimal reciprocal interference for all traffic types. In the case of ATM traffic, this results in the requirement for load distribution which is as even as possible over all trunks of a trunk group. Otherwise, connections on trunks with high utilization would suffer a greater delay period in the associated queues than on trunks with lower utilization.

The disadvantage of the described hunting strategy method is that, with high utilization of the trunk group, in the event of a connection request for a high bit rate connection, it may no longer be possible in some cases to accept this connection, since, although many gaps are available, none of them is large enough. Furthermore, in particular in the case of low

utilization of the trunk group, uneven load distribution ("unbalanced load") results.

SUMMARY OF THE INVENTION

In one embodiment of the invention, a method for determining a connection path in a communications network, comprising, routing a plurality of connections via a plurality of trunks between two adjacent network nodes and which reserve transmission capacities on the plurality trunks, determining which of the plurality of trunks, at least one additional connection is to be accommodated, using a search algorithm on the basis of an acceptance criterion to determine if the connection can still be accommodated, wherein a classification of the additional connection into two classes is carried out, performing a check when one of the classes is determined to be an HBR in order to ascertain whether a freely available residual transmission capacity $C_r(T_i)$ of the determined trunk is equal to or greater than a peak bit rate of the additional connection and, the trunk whose free residual transmission capacity most exceeds the peak bit rate of the connection is selected from the determined trunks, and performing a check to ascertain whether a remainder from a modulo-division of the freely available residual transmission capacity $C_r(T_i)$ of the determined trunk by the peak bit rate of highest bit rate connections is equal to or greater than the peak bit rate of the additional connection and the trunk whose remainder from modulo-division of the free residual transmission capacity by the peak bit

rate of highest bit rate connections least exceeds the peak bit rate of connection selected from the determined trunks, otherwise an additional search cycle is started to determine whether the freely available residual transmission capacity ($C_r(T_i)$) of the determined trunk is equal to or greater than the peak bit rate of the additional connection and, the trunk whose free residual transmission capacity least exceeds the peak bit rate of the connection is selected from the determined trunks.

In one aspect of the invention, there is the search cycle beginning with a first trunk of the plurality of trunks, and is applied to each trunk ($T_1 \ldots T_n$) and ends with the last trunk in the plurality of trucks.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is explained in detail below with reference to an embodiment shown in the drawing, in which:

Fig. 1 shows an exemplary configuration on which the method according to the invention is carried out.

Figure 2A shows an exemplary search algorithm according to the invention.

Figure 2B shows an exemplary search algorithm according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention discloses a way in which connection paths can be determined in a communications network, even with non-homogeneous traffic.

An advantageous feature of the invention is the provision of a new hunting strategy. The search to identify the largest gaps for high bit rate connections produces excellent results in terms of blocking probability and load distribution.

Fig. 1 shows a communications network. In this example, 4 network nodes $N_1 \dots N_4$ are indicated. Of course, more or less network nodes can be used in the network. Two network nodes, for example network nodes N_1, N_4 are interconnected via a trunk group TG. A plurality of trunks $T_1 \dots T_n$ are disposed in the trunk group TG. Each of the trunks $T_1 \dots T_n$ has a specified transmission capacity C_s as the physical transmission parameter. The residual transmission capacity $C_r(T_i)$ $(i=1 \dots n)$ which is freely available for further connections is derived from the physical transmission capacity C_s minus the sum of the peak bit rates R_{pj} of the m connections $(j=1, 2 \dots, m)$ instantaneously carried thereover.

It is assumed below that a connection V is to be set up from the network node N_1 to the network node N_4. The corresponding relationships are illustrated in ~~Fig. 2.~~Figs. 2A and 2B.

Accordingly, a classification of the connections into highest bit rates and non-highest bit rate connections HBR, N-HBR is initially carried out. The criterion determining which connections are to be regarded as having the highest bit rate, is, for example, prescribed by the corresponding service. The trunks $T_1 \dots T_n$ are then subsequently examined to ascertain whether the new connection V can be accommodated. A different hunting strategy is adopted according to the association of the connection V with the classes HBR, N-HBR.

The hunting strategy typically begins with the first trunk T_1 of the trunk group TG and always ends with the last trunk T_n, for highest bit rate connections after one search cycle, and for non-highest bit rate connections after one or two search cycles.

A highest bit rate connection V associated with class HBR is accepted on one of the trunks $T_1 \ldots T_n$ if the free residual transmission capacity of the latter most exceeds the peak bit rate of the connection. The new connection V is thus sorted into the "largest gap". As shown in ~~Fig. 2~~Figs. 2A and 2B, two criteria are thus required for sorting. On the one hand, the freely available residual transmission capacity of the trunk T_i currently being examined must be equal to or greater than the peak bit rate of the new connection V. On the other hand, the free residual transmission capacity must most exceed the peak bit rate of the new connection V. To do this, a variable C_r_~~Letzt~~Last_Optimum is introduced, in which the greatest currently determined value is always recorded. For the highest bit rate connections of the class HBR, the search always ends accordingly after one search cycle.

If the new connection V is a non-highest bit rate connection which is allocated to the class N-HBR, it is accepted on one of the trunks $T_1 \ldots T_n$ if the free residual transmission capacity of the latter, following subtraction of a largest possible multiple of the peak bit rate R_p(HBR) of highest bit rate connections ("ensuring the largest gaps for high bit rate connections"), least exceeds the peak bit rate of the connection V. The new connection V is thus sorted into the "smallest gap following subtraction of the largest possible reservation budget for connections of the class HBR”. As shown in ~~Fig. 2~~Figs. 2A and 2B, there are two criteria for sorting. On the one hand, the remainder from modulo-division of the freely available residual transmission capacity of the currently

examined trunk T_i by the peak bit rate of highest bit rate connections must be equal to or greater than the peak bit rate of the new connection V. On the other hand, the remainder from modulo-division of the free residual transmission capacity by the peak bit rate of highest bit rate connections must least exceed the peak bit rate of the new connection V. To do this, a variable C_r_~~Letzt~~ Last _Optimum is introduced here also, in which the lowest currently determined value is always recorded. If the search according to the aforementioned criteria is successful, the search ends after one search cycle for non-highest bit rate connections of the class N-HBR.

If the new connection V cannot be sorted on any of the trunks, a second search cycle is started. The connection V is then - without taking into account a reservation budget for connections of the class HBR - accepted on one of the trunks $T_1 \ldots T_n$ if the free residual transmission capacity of the latter least exceeds the peak bit rate of the connection. The new connection V is thus sorted into the "smallest gap". As shown in ~~Fig. 2~~Figs. 2A and 2B, there are two criteria for sorting. On the one hand, the freely available residual transmission capacity of the currently examined trunk T_i must be equal to or greater than the peak bit rate of the new connection V. On the other hand, the free residual transmission capacity must least exceed the peak bit rate of the new connection V. To do this, the lowest currently determined value is always recorded in the variable C_r_~~Letzt~~ Last _Optimum. For non-highest bit rate connections of the class N-HBR, the search ends accordingly after this second search cycle at the latest.

The current embodiment has referred to connections in general. This may involve connections of any given type. Thus, connections which transmit information according to a synchronous transfer method (STM) can be

set up using the method according to the invention as well as connections which transmit information according to an asynchronous transfer mode (ATM).

METHOD FOR DETERMINING A CONNECTION PATH IN A COMMUNICATIONS NETWORK BETWEEN TWO ADJACENT NETWORK NODES

Abstract

In order to authorize a connection on a trunk group comprising a plurality of trunks between two adjacent network nodes, a search algorithm determines the trunk on which this connection can still be accommodated. To do this, a classification of this new connection is first carried out, according to which different search cycles are instigated, with which a trunk with adequate free residual transmission capacity is determined. If the search is unsuccessful, the connection is rejected.